Seat No.: _____ **Enrolment No._____**

GUJARAT TECHNOLOGICAL UNIVERSITY

BE SEM-V Examination-Nov/Dec.-2011

Subject code: 150403 **Date: 26/11/2011**

Subject Name: Chemical Reaction Engineering

Time: 2.30 pm -5.00 pm

Total marks: 70

Instructions:

1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**

Q.1 **(a)** The composition of sulfurile chloride to sulphur dioxide and chlorine is carried out in a closed vessel (batch reactor) for 60 min at 610^0 F. Calculate the time required to decompose 95 % sulfurile chloride when the reaction proceeds according to first order reaction and the reverse reaction is negligible. The specific reaction rate constant at 610^0 F is 0.00132/min. **07**

(b) The non-elementary reaction, **07**

$2A + B \leftrightarrow A_2B$

Takes place by the following mechanism

$$2A \overset{K_1}{\leftrightarrow} A_2^* \text{ and } A_2^* + B \overset{K_2}{\leftrightarrow} A_2B$$

Find the rate equation of the reaction.

Q.2 **(a)** Find the overall order of the irreversible reaction **07**

$2H_2 + 2NO \rightarrow N_2 + 2H_2O$

From the following constant volume data using equimolar amount of Hydrogen and Nitric oxide.

Total pressure, mm Hg	200	240	280	320	360
Half life, sec	265	186	115	104	67

(b) Enzyme E catalyses the fermentation of substance A (the reactant) to product R. Find the size of mixed flow reactor needed for 95 % conversion of reactant into a feed stream (25 liters/min)of reactant (2 mol/lit) and enzyme concentration are given by A $\rightarrow$R **07**

$$(-r_A) = \frac{0.1c_A}{1+0.5c_A} \text{ mol/lit, min}$$

OR

(b) First order irreversible reaction A $\rightarrow$ B is carried out in a plug flow reactor followed by an equal size CSTR in series. The concentration of A in the feed is 1 kgmole/m^3 and the residence time in each rector is 1/3600 sec^{-1}. Find the concentration of A at the exit of the system. **07**

Q.3 **(a)** Define space time and space velocity. Derive the design equation of steady-state mixed flow reactor. **07**

(b) Explain the qualitative product distribution for irreversible first order reactions in series. **07**

OR

Q.3 (b) A gaseous feed of pure A (1 mol/lit) enters a mixed flow reactor (2 liters) and reacts as follows:

$2A \rightarrow R$

$(-r_A) = 0.05\ c_A^2$ mol/liter, sec

Find what feed rate (lit/min) will give an outlet concentration $c_A = 0.5$ mol/lit.

Q.4 (a) Explain the contacting patterns for various combinations of high and low concentration of reactants in continuous flow operations for parallel reactions. **07**

(b) Explain Differential and integral method of analysis with their merits and demerits. **07**

OR

Q.4 (a) The aqueous reaction, **07**

$A \rightarrow R + S$ proceeds as follows :

Time, min	0	36	65	100	160	∞
C_A, mol/lit	0.1823	0.1453	0.1216	0.1025	0.0793	0.0494

$c_{A0} = 0.1823$ moles/lit

$c_{R0} = 0$

$c_{S0} \approx 55$ moles/lit

Find the rate equation for this reaction.

Q.4 (b) Zero order homogeneous gas reaction, $A \rightarrow rR$ proceeds in a constant volume bomb with 20 % inerts. Pressure rises from 1 to 1.3 atms in two minutes. If the same reaction takes place in a constant pressure batch reactor, what is the fractional volume change in 4 minutes if the feed is at 3 atms and consists of 40% inerts. **07**

Q.5 (a) A homogeneous gas reaction $A \rightarrow 3R$ has a reported rate at 215^0 C, $(-r_A) = 10^{-2}\ c_A^{1/2}$ (mol/lit, sec) **07**

Find the space time needed for 80% conversion of 50% A & 50% inert feed a plug flow reactor operating at 215^0 C and 5 atm. ($c_{A0} = 0.0625$ mol/lit)

(b) A first order reaction is to be treated in a series of two CSTR. Show that the total volume of the two reactors is minimum when the reactors are equal in size. **07**

OR

Q.5 (a) Reactant A decomposes in a batch reactor **07**

$A \rightarrow$ products

The composition of A in the reactor is measured at various times with results shown below. Find a rate equation to represent data using integral method of analysis.

Time, s	0	20	40	60	120	180	300
Concentration, C_A, mol/lit	10	8	6	5	3	2	1

(b) Find the rate equation by differential method of analysis using the data given in previous problem. **07**

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